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EXPENDITURE ON FOOD AND NUTRITION

In studying expenditure on food in relation to nutrition it is usual to employ data averaging the outlay on food and the nutritional intake of representative groups of families. Highly instructive as such an analysis can be, it necessarily neglects the behaviour of the individual family. Hence it cannot tell us what would be the minimum amount necessary to ensure that every family actually does purchase a sufficiency of food or, whether it is at all possible to fix such an amount within reasonable economic limits. This present article tries to throw some light on these questions. It discusses in detail the intake of protein and calories in June 1942 of 161 individual families, and compares it with the average intake of groups of these families arranged in order of their relative expenditure on food per ' man '.[1] An analysis of this kind could only be carried out on a small sample ; interesting, therefore, though its results may be, no general validity can be claimed for them.

In order to obtain our averages of consumption of foods at different levels of expenditure, we have split up the 161 families which supplied two-weekly budgets,[2] into eight groups, ranging from an expenditure on food per ' man ' per week of less than 9 shillings to 15 shillings and over, the intermediate groups always differing from their immediate neighbours on either side by one shilling.

Table I shows for each of these groups the amounts of food bought per ' man ' per week with the housekeeping money. Also included are milk obtained free, and potatoes and eggs from allotments, while other allot-

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[1] A brief note on our scale of ' man ' values is given in Appendix A.

[2] A summary analysis of these budgets was published in BULLETIN Vol. 4, *Supplement 1.*

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EDITORIAL NOTE.

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The views and recommendations put forward in signed articles are those of the respective authors, and not necessarily those of the Institute of Statistics or of the Editor of the BULLETIN.

TABLE I

Quantities of Food Consumed per ' Man ' per Week at Different Levels of Expenditure on Food

	Budgets in June 1942									
Av. Food Expediture per 'Man' per Week	Group (I) 7/4¾	Group (II) 9/5	Group (III) 10/5¾	Group (IV) 11/5¾	Group (V) 12/6¾	Group (VI) 13/6¾	Group (VII) 14/6½	Group (VIII) 16/8¼	All Groups 11/5½	Nat. aver. 1934 11/-
Meat (incl. cooked) oz.	16.8	18.0	22.0	21.1	22.0	22.5	20.9	22.8	20.5	39.0[1]
Sausages oz.	2.3	3.7	3.6	3.7	5.1	4.3	6.4	9.2	4.5	
Bacon oz.	4.5	4.5	4.6	5.0	5.1	4.7	5.2	5.6	4.9	8.8[1]
Fish oz.	1.4	3.1	3.0	3.4	4.6	5.8	6.1	10.5	4.3	11.1[1]
Eggs No.	2.0	1.6	1.8	2.1	2.0	2.6	2.2	2.0	2.0	3.6
Cheese oz.	4.2	3.5	3.7	4.3	4.3	4.5	4.5	4.9	4.1	4.0
Milk total pt.	5.3	4.7	5.0	5.7	5.6	6.4	7.3	6.1	5.6	4.1
Butter oz.	2.5	2.3	2.5	2.3	2.7	2.8	2.7	2.6	2.5	9.8
Margarine oz.	5.7	5.4	5.5	5.6	5.3	5.5	5.5	4.7	5.4	3.0
Other Fats oz.	2.2	2.5	2.8	2.8	3.2	3.4	3.0	3.2	2.8	3.4
Sugar oz.	11.6	11.7	11.7	11.0	10.9	11.4	13.2	11.4	11.5	22.5[2]
Bread oz.	72.7	90.4	86.1	81.0	81.8	75.3	90.1	77.7	82.3	88.2[2]
Cake & Biscuits oz.	2.8	6.3	9.4	7.2	10.4	15.6	11.7	15.9	9.0	
Flour oz.	11.6	5.7	9.6	8.0	16.7	10.9	8.4	8.5	9.8	8.4[2]
Potatoes oz.	65.0	78.8	69.5	64.6	78.8	81.3	91.2	87.1	74.9	80.0
Tea oz.	2.6	2.5	2.5	2.6	2.4	2.9	2.9	2.9	2.6	3.5
Cereals (excl. oats) oz.	1.7	2.5	3.4	3.3	3.6	4.2	3.6	4.4	3.2	—
Oats oz.	0.8	1.4	0.7	1.9	0.6	0.2	0.7	0.6	1.0	—
Dried Legumes oz.	0.2	0.7	1.2	0.5	0.8	0.7	0.6	0.9	0.7	—
Dried Fruit oz.	1.5	1.9	1.9	2.6	3.6	2.2	4.3	3.7	2.6	—
Jam, Syrup, Honey oz.	1.8	3.6	4.1	4.6	5.4	5.8	4.2	6.3	4.3	6.5[2]
Cocoa oz.	0.4	0.3	0.5	0.4	0.6	0.8	0.5	0.5	0.5	—
[3]Fruit & Veg. Expend.	4½d.	8¾d.	8½d.	12½d.	15d.	15¾d.	19½d.	20¾d.	12d.	16½d.[2]
[4]Sundries Expend.	6d.	10d.	12¾d.	19d.	18¼d.	20d.	25d.	37d.	17d.	10d.[2]
No. of Families in group	16	20	22	28	22	16	16	21	161	—
Av. No. of Pers. in Family	6.8	6.4	5.3	4.7	4.6	3.5	3.5	3.3	4.8	—
'Man' Value per Person	0.70	0.76	0.76	0.75	0.77	0.74	0.74	0.80	0.75	0.80[5]

ment produce and meals obtained free or paid for out of earners' pocket money, are excluded from our estimates. Cooked meals purchased with the housekeeping money are included by us under ' sundries,' and the number of full meals thus obtained is set out in Table II. These meals should be taken into account when considering the average consumption of potatoes, bread, and flour, of each group. Children's meals have been converted into ' full ' meals by multiplying them by 0.55, *viz.*, the average ' man ' value of a child. Only luncheons and dinners are counted in Table II ; supplementary meals have been disregarded.

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[1] Allowance made for wastage in distribution. [2] Approximately. [3] Excluding expenditure on potatoes and, except for National Average 1934, also on dried fruit and vegetables. [4] Including expenditure on tinned fish and meat, and meals out, except for National Average 1934. [5] Assumed.

TABLE II.

Meals out per 'Man' per Week

Food Expend. per 'Man' per wk.	No. of Meals[1] free	paid	Expenditure
under 9s	0.9	0.1	1¼d.
9s—10s	0.1	0.5	4½d.
10s—11s	—	0.5	4¼d.
11s—12s	—	0.7	7¾d.
12s—13s	—	0.6	7d.
13s—14s	—	0.8	7½d.
14s—15s	—	1.0	10¾d.
15s & over	0.1	1.7	19d.
All groups	0.14	0.68	7d.

The last column in Table I gives the average national consumption of the several foods in 1934, based on the data quoted by Sir John Orr in *Food, Health, and Income.* Certain adjustments have been made by us so as to allow for wastage in the distribution of meat and fish, and also for the industrial consumption of sugar and fruit. This latter was necessary in order to avoid a double counting when calculating the nutritional intake from jam and ' sundries.'

According to the Ministry of Labour cost of living index, the average rise in the price of food from 1934 to June—July 1942, was 31 per cent. The average national expenditure on food in 1934 thus approximately corresponds to the average expenditure in June 1942 of group (VII). Yet it will be found that there exists a greater similarity between the average purchases of group (VI) and the national averages, not only as regards the main carbohydrate foods, which have remained unrationed, but also as regards cheese, jam, and cooking fats. Average consumption of milk in group (VI) was, however, substantially above the national average in 1934. The larger consumption of milk per ' man ' in all our groups, as compared with that in 1934, not only reflects the general upward trend in the consumption of milk since 1934, reinforced by the Government milk scheme, but also the larger number of children in proportion to the number of adults of our sample, as compared with the national average. The difference is indicated in the figures of ' man ' value per person, given in the last row of Table I.

Altogether, the picture of average consumption of food revealed in Table I is very much what one might have expected, showing a tendency for increasing purchases of the more expensive foods—especially meat, fish, milk, cake, and fruit and vegetables—with increasing total outlay on food. Yet in view of the comparative smallness of our sample, the statistical cohesion of the several expenditure groups displayed in Table I is remarkable. The increasing average quantities bought with increasing average outlay on food are naturally reflected in the average figures of calorific and protein intake, which are given in Table III.[2] But Table III also shows for each expenditure group the ranges of

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[1] A child's lunch or dinner is counted as 0.55 of a full meal ; supplementary meals are disregarded.

[2] It may here again be pointed out that the data of nutritional intake are derived from the quantities of food bought by the housewife—with the exceptions mentioned above. If meals obtained free are included, then the nutritional intake of group (I) per ' man ' per day rises to 2,900 calories and 91 grammes of protein, of which 45 grammes are animal protein. The ranges of that group remain unchanged.

TABLE III

Nutritional Intake per 'Man' per Day at Different Levels of Food Expenditure

Group	Expenditure	Calories Average	Calories Highest	Calories Lowest*	Total Protein Average	Total Protein Highest grammes	Total Protein Lowest	Animal Protein Average	Animal Protein Highest grammes	Animal Protein Lowest
(I)	under 9s	2740	3340[1]	2160[2]	88	109[1]	65[2]	43	57	29[2]
(II)	9s—10s	3000	3670[3]	2400[4]	96	115[3]	76[4]	43	57	31
(III)	10s—11s	3180	4870[5]	2300[6]	103	154[5]	71[6]	48	59	39
(IV)	11s—12s	3250	4160[7]	2720	106	138[7]	82	54	71	45
(V)	12s—13s	3460	4550[8]	2910[9]	113	144[8]	89	54	68	41[9]
(VI)	13s—14s	3440	4170[10]	2780[11]	115	140[10]	83[11]	59	70	50
(VII)	14s—15s	3740	4720[12]	3300	124	163[12]	100[13]	63	87[12]	50[13]
(VIII)	15s and over	3840	5300[14]	3030	131	173[14]	106[15]	69	105	54[15]
All Groups		3240	—	—	106	—	—	52	—	—
Nat. Av. 1934		3570	—	—	112	—	—	64	—	—

[1],[2] etc. Identical indices refer to the same family. *The household budgets of these families in groups (I) to (VI) are analysed in Table IV.

TABLE IV

Six Families with Very Low Calorific Intake relative to their Expenditure on Food

Group	Pers- No.	'Men' No.	Food Expend. per 'Man' per Wk. s. d.	Total Protein per 'Man' per Day grams.	Family Rations Bought[1] Cheese	Family Rations Bought[1] Meat	Meat Price per lb. d.	[2]Weekly Outlay on Fruit & Veg. Total d.	[2]Weekly Outlay on Fruit & Veg. Greens & Roots d.	Family Consumpt. of Milk per Week Ord. pt.	Family Consumpt. of Milk per Week Govt. pt.	Family Consumpt. of Milk per Week School pt.	Weekly Household Expenditure on Food s. d.	Weekly Household Expenditure on Fuel & Light s. d.	Weekly Household Expenditure on Rent s. d.	Total Household Expen. s. d.	Weekly Earnings £ s.
(I)	8	5.28	6 11	65	none	1.3	17	26½[3]	5¼	¾[6]	7	8⅓	36 5½	12 3	8 6	76 4¾	4 10
(II)	6	5.00	9 3½	76	full	1.5	15¼	42	15	16	—	3⅓	46 5½	4 6	12 6	77 5	[8]
(III)	3	2.18	10 0½	71	full	1.2	16¼	38¾	25¼[4]	7	7	—	21 10¾	8 4	27 6	71 10¾	4 0
(IV)	3	2.45	11 1	96	full	1.4	13½	55	22	14	—	3⅓	27 2	7 0½	12 6	64 2	[9]
(V)	4	3.55	12 4½	95	¾	1.4	16½	67	13¼[4]	13⅞[7]	—	—	43 11	5 0	17 6	80 0½	[10]
(VI)	3	2.35	13 8½	83	¼	1.7	17¼	51	14½[5]	8	—	1⅓	32 3	9 10	15 1	118 0	8 4

[1] The meat 'ration' is greater than unity, as cooked meat (rationed on points) and ham (unrationed) are included.

[2] Excluding potatoes : including tinned and dried fruit and vegetables.

[3] First week : tin of pineapple 1/1½ ; second week : tin of pears 1/9.

[4] Some greens from allotment. [5] Each week one cauliflower at 1/-. [6] Tinned. [7] 1⅞ tinned. [8] Not given ; housekeeping money £4.

[9] Not given. [10] Not given ; housekeeping money £4 9s.

nutritional intake. As soon as we turn to these, the picture loses its smoothness. We now obtain some idea of the wide fluctuations that combine to produce the steadily progressing averages. In Table III these differences in the nutritional values bought with a given expenditure by individual families are only indicated ; they will be considered in further detail below.

Table IV draws a rough outline of the expenditure pattern of the six families with the lowest calorific intake per 'man' in groups (I) to (VI) of Table III. Their outlay on food per 'man' per day ranged from about one shilling to 1s. 11½d.; they all bought with it less than 3000 calories. Each of these six families took their full rations of butter and tea. Families (II) to (VI) also bought their full allowance of bacon ; family (I) bought only half of it. The differences between total household expenditure and earnings represent the earners' pocket money and savings. No information as to their savings was available for the two families of groups (II) and (V) ; for the remaining four families weekly savings were given as follows : group (I), none ; group (III), 1 shilling ; group (IV), 6 shillings ; group (VI), 14 shillings and sixpence.

It seems worth drawing attention to the fact that the averages in Table III indicate a tendency for the rates of change of animal protein and expenditure to move together, and,[1] in a much closer relation, those of calories and total protein.[2] In other words, the total intake of protein is, in general, directly dependent on the amount of calorific intake, while the supply of first class protein is partly determined by total expenditure on food, beyond a certain minimum guaranteed through the rationing of the main sources of animal protein, and the supply of free and cheap milk to children and mothers. The close connexion between calorific intake and total intake of protein is a phenomenon of war-time nutrition with its restrictions on the consumption of foods of high calorific value but containing no protein, *viz.*, sugar and fats.

That the ranges marked out in Table III for the nutritional intake of the several groups do not represent stray occurrences, but may rightly be considered as the maxima and minima of coherent series of nutritional intake at a given level of expenditure on food, is borne out by the picture of nutritional intake in relation to expenditure shown by our Diagram, which is supplemented by Table V. They together illustrate the calorific intake and the intake of animal protein per 'man' per day of the 161 families, the Diagram giving the central group of 100 families, and Table V the remaining 61 families.[3] In both cases the families are represented by their serial numbers, allotted to them in order of their expenditure on food per 'man.' The meaning of these numbers in terms of weekly expenditure on food is interpreted in Table VI. Free meals were obtained by members of the families nos. (1), (2), (5), (11), (14), and (141), and the actual nutritional intake per 'man' per day amounted for each of these families to at least 3,000 calories and 100 grammes of protein.

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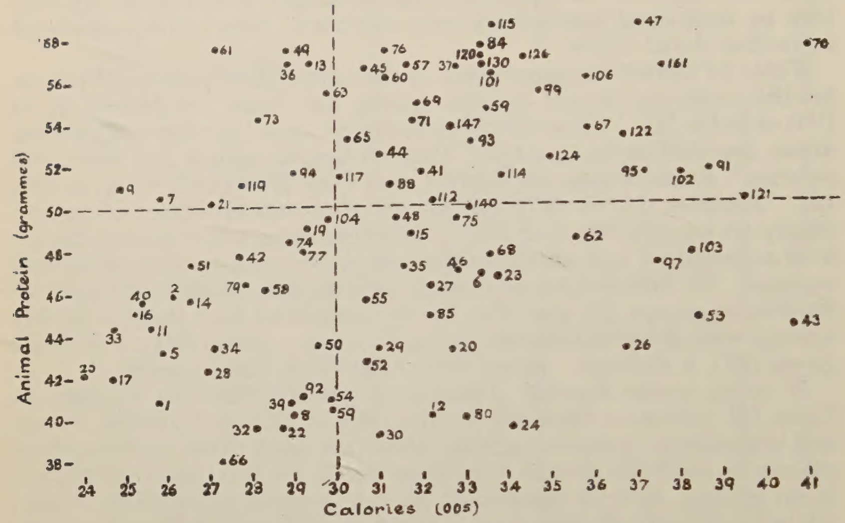
[1] The data referring to the ranges show, however, that this does not hold good for individual families.

[2] The correlation coefficient for calories and total protein is 0.95, with a possible error of less than ± 0.01. For a further statistical discussion on these points see Appendix B.

[3] Excluding nutritional intake from meals obtained free.

NUTRITIONAL INTAKE PER 'MAN' PER DAY OF 100 OUT OF 161 FAMILIES

Calories and Animal Protein



It will be observed that the Diagram is in fact three-dimensional, the 'height' of each point being indicated by the serial figure of the family, which roughly measures outlay on food in terms of relative expenditure. If we consider any section of the Diagram, either horizontal or vertical, it appears that, for the individual family, nutritional intake in terms of calories and protein is largely independent of the actual outlay on food. The ranges in Table III already demonstrated that widely varying amounts of calories and protein are obtained for a given expenditure. The Diagram states the same fact in more detail and shows it from a different angle: we here find that a wide range of expenditure procures the same quantities of protein and of calories. Consider, for instance, the families in the neighbourhood of the line which cuts the Diagram vertically at 3,000 calories. Their serial numbers range from 13 to 117, that is, from an expenditure on food per 'man' per week of 8s. 2d. to 13s. 7d. Family number 13 obtained free milk under the Government scheme, and their intake of animal protein per 'man' per day was over 56 grammes, as compared with an intake of about 50 grammes by family number 117. It so happens that the serial numbers 19, 104, and 117, lie close also to the horizontal indicating an intake of animal protein of 50 grammes. Thus, similar amounts of calories and of animal protein were obtained by families whose outlay on food varied as widely as from about 9s. 3d. to 13s. 9d. In the same way, any small cluster of dots can be picked out in the Diagram, and the range of expenditure on that particular nutritional intake interpreted with the help of Table VI.

APPENDIX A: OUR SCALE OF 'MAN' VALUES

When, in spring 1940, the Institute of Statistics undertook the first enquiry in this series, it was necessary to decide on a scale for assessing

TABLE V.

61 *Families with Very Low or Very High intake of Calories or Animal Protein* (*Serial Nos.*)

	Intake per 'Man' per Day					
Animal Protein grammes	under 38	38—50	50—59	59—65	65—70	70 & over
Calories under 2400	4	38				
2400—3000	3; 10	(*a*)	(*a*)		82	72
3000—3500	18 ; 31	(*a*)	(*a*)	86; 89; 90 98; 113; 132 139; 141	109; 116 118; 136	134; 145 150
3500—3800		(*a*)	(*a*)	78; 81; 108 123; 127 144; 149	87; 105 110; 138 143; 148	159
3800—4100		(*a*)	(*a*)	64; 125 135; 154	142; 151; 155 156; 158	128
4100 & over		56	83; 137	107; 111; 129	100	131; 133; 146 152; 153 157; 160

(*a*) See Diagram.

TABLE VI

Sequence of Families in Order of Food Expenditure per 'Man' per Week

Expenditure	Serial No.	Expenditure	Serial No.
under 7/0	1— 5	12/6—13/0	94—108
7/0— 8/0	6—10	13/0—13/6	109—114
8/0— 9/0	11—16	13/6—14/0	115—124
9/0— 9/6	17—28	14/0—14/6	125—131
9/6—10/0	29—36	14/6—15/0	132—140
10/0—10/6	37—48	15/0—15/6	141—147
10/6—11/0	49—58	15/6—16/0	148—150
11/0—11/6	59—75	16/0—17/0	151—153
11/6—12/0	76—86	17/0—18/0	154—158
12/0—12/6	87—93	19/8—20/8	159—161

the relative nutritional requirements of the several age and sex groups. It was essential that this scale should be easy to understand and simple to apply. No generally accepted scale of that kind has as yet been laid down, and we had therefore to evolve a scale of our own with the help of various existing ones. Table A shows the scale thus obtained side by side with a scale of relative energy requirements derived from data that were published by Sherman in 1941.[1] It will be seen that as compared with Sherman, we allowed relatively more food to an adult woman and a child of the age group from three to five years, and relatively less to children and young people from ten to fifteen years old. On balance, however, the error is negligible for each single expenditure group,[2] and in all probability also for any individual family of our sample.

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[1] *Chemistry of Food and Nutrition,* 6th Edition, p. 494, ff.

[2] This has been tested. For the children's and young persons' requirements according to Sherman's scale, we took the *averages* of his minimum and average requirements for each group.

TABLE A

Relative Energy Requirements for Adults and Children

		Institute	Sherman	
			min.	av.
Adult male		1.00	1.00	
Adult female		0.85	0.80	
14—15 male		0.85	0.88	1.03
14—15 female		0.80	0.80	0.90
Children	10—13	0.70	0.75	0.90
	6—9	0.60	0.56	0.64
	3—5	0.50	0.38	0.44
	under 3	0.33	0.32	0.35

We also used our scale of energy requirements for assessing the relative protein requirements of the members of the families. For this we have the full support of Sherman. He says :[1] ' It is because the high protein requirement of childhood (for young children nearly twice as much per unit of weight as for adults) is paralleled by an equally high energy requirement that the diet of the child need not contain a higher percentage of its calories in the form of protein than does the ordinary diet of the adult, if the protein for the child is well chosen.' Sherman considers 3,000 calories and 75 grammes of protein per day the minimum requirements per human unit, while in those instances where we have touched on the sufficiency or insufficiency of the nutritional intake of the families which supplied budgets for our inquiry, we have accepted as the basic requirements those suggested by the B.M.A., *viz.*, 3,000 calories and 100 grammes of protein, of which 50 per cent. should be first class protein.

APPENDIX B: CORRELATION OF EXPENDITURE, CALORIES, AND ANIMAL PROTEIN

We have worked out for the 161 families the correlation between outlay on food per 'man' per week, and intake per 'man' per day of calories and animal protein. In the following formulae the letters X and x signify expenditure, Y and y calorific intake, and Z and z intake of animal protein. Expenditure is reckoned in pence, calories in units, and protein in grammes. The average expenditure—unweighted by the number of 'men' per family—is 144.4 pence, and the average nutritional intake 3336 calories and 54.5 grammes of animal protein. The coefficients of correlation are : $r_{yz.x}=0.38 \pm 0.07$; $r_{xz.y}=0.60 \pm 0.05$; $r_{yz.x}=0.25 \pm 0.07$. They yield the following equations :

$$(1)\ X=0.02Y+1.53Z-5.7$$
$$(2)\ Y=7.32X+13.22Z+1560$$
$$(3)\ Z=0.20X+0.005Y+9.3$$

The coefficient $r_{xz.y}$ and equations (1) and (3) indicate that there exists a correlation between the intake of animal protein and expenditure, and that, if the calorific intake is given, differences in expenditure tend to be reflected in differences in the intake of animal protein. On the other hand, from equation (2) it appears that, with the intake of animal protein fixed, expenditure has little effect on calorific intake. Lastly, the coefficient $r_{yz.x}$ is so small as to be scarcely significant, and the intake of calories may have little reference to the intake of animal protein. Of course, a slight positive connexion between these two cannot quite be ruled out ; it might be interpreted as the natural desire for a balanced diet, in which the intake of animal protein bears some relation to the total calorific intake.

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[1] *Op. cit.*, p. 212.

T. SCHULZ.

PROTEIN ALLOCATIONS.

In August 1941[1] an estimate was made of the then current protein supplies available to the consumer : it was estimated that animal protein supplies were providing the average person with 205 grms.[2] per week, and that vegetable sources provided about 280 grms. These calculations were based on the assumption of weekly consumption of 15 oz. Meat, 4 oz. Bacon, 2 oz. Cheese, 4 pints Milk, 1 Egg, giving 175 grms. of Animal Protein from rationed sources, while unrationed animal protein sources were estimated to yield a further 30 grms. Vegetable protein sources were estimated to give 280 grms. but probably this figure should have been increased by about 10 per cent. to make allowance for the protein contained in potatoes which was neglected in that article. It was suggested that to endeavour to replace the shortage of animal protein by importing further wheat (providing vegetable protein) was probably ill-advised, and that the substitution in import of cheese and meat would be far more desirable both nutritionally and strategically.

The policy of this last winter when the cheese ration has been maintained at a very high level (about 2½ times the pre-war average consumption of .19 lbs. per head per week) was therefore very much in accordance with the views expressed in that article. It was possible, at that level, to counteract most of the effects on protein supplies of the sharp decline in Milk supplies : in terms of proteins, 2½oz. of cheese are equivalent to 1 pint of milk. The announcement that the cheese ration will be cut to 4 oz. as from the 6 February must however cause some concern.

The animal protein supplies available for the various sections of the community will be as shown in the accompanying table. ' Supplies ' here means ' Rations ' plus estimated supplements : it is in fact the upper limit of protein intake. The figures are rough,[3] and do not claim an accuracy of more than 10 per cent. The Milk and Dried Eggs estimates include full priorities to all classes entitled to them, and 1⅔ pints of milk in schools for the children 5—18. The estimated upper range of animal protein available from ' points ' foods is generous. It has been obtained by examining the ' protein per point ' value of all foods so rationed. To reach 40 grms. entails that a very considerable proportion of the points allocation should be used for purchasing Grade III Canned Salmon which it is relatively difficult to obtain. The estimated consumption of unrationed animal protein sources—25 grms. —seems not too high, since the 'points' scheme has incorporated much of what was available in the summer of 1941.

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[1] BULLETIN Vol. 3, No. 12.

[2] There is considerable controversy still raging among the bio-chemists concerning the minimal requirements. The pre-war maximum and minimum standards for the adult male were however : League of Nations 350 grms. per week, Bacharach and Drummond 210 grms. per week. Even on the latter standard we must be close to the borderline so far as animal protein is concerned.

[3] Based on McCance and Widdowson's Conversion Tables : for Dried Eggs, Household Milk and ' Points,' from information supplied by the Ministry of Food.

Maximum Weekly Supplies of Animal Protein: 4 wks. following Feb. 6th, 1943:

GRMS.

	Adult	Child		Expectant Mother	Nursing Mother and Child 0—1
		1—5	5—18		
Meat	55	28	55	55	83
Bacon	14	14	14	14	28
Milk	36 (2 pints)	126 (7 pints)	93 (5⅙ pints)	126 (7 pints)	288 (16 pints)
Cheese	28	28	28	28	56
Eggs	2	2	2	7	4
Dried Eggs	33	66	33	33	99
Household Milk	11	22	11	11	33
'Points'	0—40	0—40	0—40	0—40	0—80
Fish, Offals, Sausages, Chicken, etc.	25	25	25	25	30
Total (in round figures)	200—240	310—350	260—300	300—340	620—700

To this should be added for the adult and the child 5—18 categories small additions to represent the animal protein consumed in schools, works canteen and restaurant meals (other than school milk). This represents apparently[1] about 4 or 5 meals per week per head in these two categories—sufficient to add at most a 20 per cent. supplement to the figure above. It still remains clear that though the nursing mother and the child from birth to 5 years may be allocated sufficient animal protein, the allocations to the adult, the older child and the adolescent are likely to be little if any above their marginal requirements. It is also probable that the expectant mother is not getting enough. These are of course allocations, and it is known from many sources that milk priorities allocated to individuals in the family are not generally only consumed by these individuals but the whole of the amount of milk coming into the house is regarded as a common pool. This will tend to make any deficiency general rather than confined to specific groups of the population.

The effects of a shortage of animal protein have perhaps not begun to demonstrate themselves in any startling way. Nevertheless one effect of the shortage may go some way to explain the difficulty of the Ministry of Food to persuade people to eat more potatoes *instead of*, rather than *as well as* bread. For the shortage of animal protein, and the restriction by placing on 'points' of the leguminous, breakfast cereal and biscuit sources of vegetable protein, must mean an increased demand for the

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[1] See statements in House, *Oct. 22nd* 1942. 'The latest statistics of meals (including breakfasts, main meals, subsidiary meals and tea) served in catering establishments are as follows

	Million per week
Private catering establishments	62
Canteens	44.5
British Restaurants	2.0

Nov. 26th 1942. A long statement indicating that only 858,000 children were receiving school meals.

remaining vegetable sources, e.g. bread flour and to a lesser extent potatoes and other vegetables.

If the Minister of Food wishes to relieve the strain on shipping that current wheat consumption entails, it might be wise of him to increase the animal protein supplies : this might then further provide the circumstances under which a wheat-potato substitution would be effective. The form in which this increased animal protein supply could be provided must necessarily be one in which small bulk and high protein content are combined ; cheese, dried eggs, dried milk, and dehydrated meat seem the more likely forms. Dried eggs have been welcomed by the majority of housewives though the Household Milk has proved more difficult to popularise largely, it seems, because of the 'bother' involved in its use. The dehydrated meat, the promise of which received such publicity earlier in the winter does not yet seem to have appeared and will need much propaganda to popularise its use. That cheese consumption has not in the past averaged the full ration reflects not only upon the conservative attitude of the consumer, but also upon the poor quality of the cheese supplied. A greater variety of types and one half the propaganda effort spent on potatoes would go a long way to remedy this under consumption : in particular a further attempt to make the housewife cook rather than serve raw the poor quality cheese available would repay the effort. Certainly it seems unwise to penalise by cutting the ration those who *do* take up the full amount, rather than maintaining the 8 oz. ration to allow them to consume, while it is still fresh, what others do not want.

Every effort should therefore be made to maintain the cheese supply within the limits of available shipping. Linked to this must always be a home production policy substituting milk for meat. The arguments for this latter more efficient use of our own productive resources becomes strengthened rather than weakened as the war progresses and pasture ploughed in 1939-40 has to be allowed back into temporary grass in order to regain its fertility.

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NATURAL *VERSUS* SYNTHETIC RUBBER.

An acute shortage of rubber may be imminent if sufficient new rubber resources have not been created before the pre-Pearl-Harbour stocks are used up.

Since new rubber plantations need some five years to mature, the bulk of production for the coming years has to be obtained synthetically. Great Britain, after the exhaustion of stocks, will become therefore almost completely dependent for the rest of the war on the development of the synthetic industry in U.S.A. This industry, unknown 15 years ago and insignificant at the outbreak of war, is now, at the most critical moment, passing through a period of infantile diseases in the form of technical difficulties and commercial rivalries. One of the outstanding obstacles towards a rapid development is caused by uncertainty about the competitive strength of synthetic in relation to natural rubber and about the general economic policy in the post-war period. It may, therefore, be useful to examine the American rubber position, and in particular the comparative cost of natural and synthetic rubber.

AMERICAN NEEDS

The present position in U.S.A. with regard to rubber supplies has been summarised in the Report of the Baruch Commission, which stated that U.S.A. would 'face both a military and civilian collapse' unless corrective measures were taken immediately. Since the report was published in September 1942, rubber stocks have continued to dwindle with disquieting speed. At the beginning of January 1943 a responsible U.S.A. administrator[1] stated that America has reached 'desperation point' with regard to rubber and that the problems of adequate synthetic production will have to be solved within seven months compared with Germany's seven years. The recent release of decisive patents by Standard Oil enforced by American anti-trust legislation is only of limited use if sufficient chemical engineers trained in the particular synthetic process are not at the disposal of the newly erected factories.[2]

The campaigns for restricted use of rubber goods has made headway in the U.K. and U.S.A. but the rate of wear and tear of motor tyres (accounting for 75% of U.S.A.'s rubber consumption) is still far above that of possible replacement. A much smaller proportion of private cars can be taken off the road in U.S.A. than in U.K. Of 28 million private cars in U.S.A. with 135 million tyres, some 20 million cars (= 100 million tyres) are said to be required for local essential[3] transport. All private cars in use accounted for 200 million passenger miles per year compared with 40 million by railways and buses. With an average consumption of 14 lbs. of crude rubber per tyre and an average life of not more than two years, a quantity of some 300,000 tons would be necessary for 'essential' private cars. With regard to reduced consumption by speed limits, gasoline rationing etc., the Federal administration is dependent on the goodwill and co-operation of the State authorities. If existing retreading capacity were more fully used, or even extended, this quantity could be reduced to 160,000 tons (retreaded tyres need 5 lbs. of crude rubber instead of 14 lbs. and may give 80% of the mileage of new ones).[4]

Tyres could also be made partly from reclaimed rubber, 400,000 tons of which can be obtained from the 480,000 tons of scrap collected. The present annual rubber deficit was estimated at 211,000 tons[5] (for military and for essential purposes excluding tyres for passenger cars). If all possibilities for retreading, reclaiming and production of synthetic rubber were used and consumption restricted, no serious shortage could occur. The competitive character of the various processes (reclaim, retread, natural and synthetic from grain, coal or petrol, tyre fabric from cotton or rayon) calls for strong intervention by the Government.

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[1] Mr. W. L. White of the War Production Advisory Board and of the Advisory Committee of the Rubber Reserve Corporation.

[2] One of the constituents of synthetic rubber, butadiene, for instance is open to violent thermal decomposition when heated under pressure, and in contact with air or oxygen it may form highly explosive peroxide.

[3] This term is open to wide interpretation.

[4] The life of tyres can be prolonged by 40% if a speed limit of 35 m.p.h. is imposed on cars.

[5] Baruch Report.

Problems of Synthetic Production

The construction programme for synthetic rubber production may, by shortcomings in the system of priorities, be delayed by some 4 months in which case the planned 400,000 tons of Buna S output for 1943 would fall short of the target by more than 200,000 tons and even military needs could not be satisfied. The erection of the necessary plants has also been retarded by the controversy between grain and petroleum interests. Production from grain alcohol is said to need only 9 months for development against 13 months for the petroleum process. The production of 1 lb. of synthetic rubber would cost 9 cents exclusive of the cost of grain and 35 cents inclusive (with grain at $1.0 a bushel); by using deteriorated grain, costs could be correspondingly reduced. 80 million bushels of wheat would finally yield 240,000 tons of rubber,[1] at the same time relieving the existing wheat surplus. However, the Baruch report decided that the bulk of rubber should be manufactured by the petroleum process. Yet it seems that private enterpreneurs are still reluctant to invest their abilities, and, partly, money, in an industry, whose doubtful post-war prospects are unattractive to investors and managerial staff. Probably in order to break down this reluctance, the newly appointed National Rubber Administrator, W. Jeffers, promising an adequate rubber supply for the middle of 1944, declared that ' never again will the U.S. be dependent upon rubber from Malaya.' This utterance, made in contradiction to statements by Vice-President H. Wallace but conforming to the attitude of many Government officials,[2] draws attention to the background of the present serious rubber position.

The fears of both consumers and producers of crude rubber run in the opposite direction, and are based on a potential competitive strength of synthetic rubber possibly achieved by protective measures. The mutual suspicions of crude and synthetic producers both work towards a slowing up of the erection of synthetic plants. The comparative costs are difficult to assess since estimates vary according to whether high or low competitive strength is to be demonstrated by those concerned.

Comparative Costs

The possible cost of synthetic rubber in general use has been given as 22 cents per lb., compared with a price of 23 cents for natural rubber before Pearl Harbour and 21.1 cents in September 1939. An expert of the B. F. Goodrich Rubber Co. stated before a Senate Committee that 26 cents a lb. would represent a ' very fair price ' for synthetic. In the autumn of 1940 synthetic rubbers were quoted: Neoprene 65—75c., Thiokol 35—60c., Vistanex 60—100c., Koroseal 50—60c., Perbunan $1.00. These are, however, special rubbers. The cost of Buna S, the most common type, is assessed between 35c. and 20c., in case of large scale production. A new Standard Oil process converting refinery gases—wasted in previous years—into butane products is said to cost 6 cents per lb. It is not clear if this price allows for depreciation, dividends, taxes, etc. Costs of synthetic rubber are largely determined by power costs, one ton of buna consuming 30,000—40,000 Kwh, compared with 20,000 Kwh for pure aluminium.

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[1] Requiring 220,000 tons of butadiene to be obtained from 200 million gallons of alcohol. 1 lb. of Buna S contains 80% of butadiene and 80% of styrene (derived from coal). 0.8 lb. of butadiene can be obtained from 85 lbs. of grain, or from 34 lbs. of coal and 67 lbs. of limestone, or from 14.6 lbs. butane (from natural gasoline) or from 11.4 lbs. of butylene (from gas oil).

[2] *Manchester Guardian*, 19th May, 1942, quoting ' United States News.'

With regard to natural rubber more than half of the costs consist of wage payments. Food represents about 50% of a family's cost of living with rice as staple food, an adult male labourer consuming some 1⅓lbs. a day (=1d. per person). A coolie collects on the average 8—10 lbs. a day on European estates (6 lbs. on Asiatic estates). On the basis of pre-war rates (45 cents per day) for a male adult tapper, the wage per coolie per lb. would amount to some 1.3 to 1.6d. (a Strait $= 2/4d.), compared with 3.35d. in 1919. The improved system of tapping after the last war doubled production and thus more than halved the costs. European supervision costs some 0.8d. per lb. Milling, packing etc. account for another 0.9d. Factor costs f.o.b. of crude rubber represent only 50% of 'all-in costs.' Depreciation and amortisation of plantations and buildings, their upkeep, taxes, interest and selling charges account for another 50%. Although rubber was sold at the bottom of depression at 2—2½d. and still production was maintained at 80% of capacity, the price hardly covered prime costs of collection and manufacture and transport costs. The companies could, however, carry on, since they had just experienced a boom period with a record average price of 2s. 11d. in 1925.

As to capital needed, the investment for a programme of 900,000 tons of petroleum-synthetic rubber is said to exceed $650,000,000, or some $550—600 per ton. Capital investment for buildings, machinery and planting with natural budded rubber on European-owned Far Eastern Rubber estates amounts to £47—55 per acre (pre-war) equalling some £235—275 per short ton.

To judge from dividends paid during the depression, 'all in costs' can hardly have been as low as the market prices,[1] as suggested by the Vice-President of Standard Oil, Mr. F. A. Howard, when he recently spoke of an actual cost of production of 3d. for cultivated trees and 1.2—1.8d. from wild trees. On the basis of present methods of production an average price of 7d. per lb. may be necessary for attracting capital. The ratio between prices of rubber (in pence) and dividend[2] may be estimated at 10 : 7 so that a rubber price of 20d. would yield an average dividend of 15%, and rubber at 3d. would allow for a dividend of some 2%.

A comparison of costs for the production of synthetic and natural rubber shows that capital investment per ton of synthetic rubber is much lower than twice that per ton of natural rubber. But a lifetime of roughly 30 years for rubber trees compares with some 12 years for machinery. Factor costs of natural rubber are largely determined by wages while those of synthetic rubber are to a considerable degree, based on power costs. The relation of these two essential items may easily change with changes in Government policy.

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[1] 1930 : 5.9d. ; 193a : 3.12d. : 1932 : 2.3d. ; 1933 : 3.25d.

[2] Since 1910 profits of rubber companies have fallen from 53% to 6% of paid capital. Although published balance sheets give in no way an exact picture of the real financial position of companies, the change in the ratio of profits to paid capital is of a magnitude which indicates a considerable decline from excess profits to an average rate of interest. When the industry recovered from the slump only 4 Malayan rubber companies paid dividends above 10%, and 20 companies between 7% and 10%, while 147 companies paid no dividend. (There were some 300 major British Rubber Stock Companies in Malaya).

PROBLEMS OF NATURAL RUBBER PRODUCTION.

Costs of natural rubber could be considerably lowered by modernising the industry. European rubber producers would benefit by using the present period for intensifying research work towards higher efficiency. By amalgamation of estates and companies and by other improvements in production, such as scientific machinery, replanting, bud-grafting, seed selection, by still better tapping methods and, if necessary, tapping of the more productive trees only, yields of rubber trees may be increased by more than 100% and a production of some 1,000 lbs. per acre instead of the present 400 lbs. achieved.

Low-cost production seems to be detrimentally affected if companies are too large in size. In the peak year of the boom, 1925, the 22 companies owning an acreage of some 3,000 acres with standard production of 1 million lbs. each were best suited for an ' all in cost ' of production of 6-8d. All companies with a standard production of 1,600,000 lbs. or over showed higher ' all in costs ' of production. In the period of recovery 1933/34 none of the 17 £400,000 companies was among the 24 companies with dividends of 7% and over. Those in possession of the relevant data may be able to establish the most efficient size. The time when rubber planters could protect high cost producers by cartels has passed, with the establishment of the bulk of the synthetic industry in the large consumer countries—U.S.A., U.S.S.R. and Germany—which were not represented in the rubber cartel countries whose legislation was outside the sphere of interests of the rubber planters. But low cost producing firms should easily be able to compete with synthetics.

Whether a synthetic rubber plant should be erected in this country has been under discussion for many years. So far the Government has not consented to establish such a plant, arguing ' that the construction would require such effort and time as could not be justified having regard to the production already arranged in U.S.A.' A synthetic plant erected in this country during the war could, if not to be used in the post-war world, be written off in the same way as other armament plants. In many fields synthetic rubber or a mixture of synthetic and natural will be superior to natural rubber and it is likely that a plant of economical size would find a ready market beyond the demand for natural rubber. The large scale development of new strategic roads in all continents will, in connection with the progress of engineering, further motorisation and with it the demand for rubber to an extent, which will leave ample room for both products after the war. Even without these prospects, none of the alleged post-war dangers of insufficient demand can be compared in magnitude with the danger of the war-time rubber shortage. The extension of capacity in U.S.A., if according to plan, will go far to cover urgent needs, but in face of so many obstacles to a quick realisation of the programme and to the safe arrival of shipments in this country supplies from U.S.A. may fall short of expectations, a possibility against which it would be safe to prepare.

S. MOOS.

DIARY.

INDUSTRIAL INTEGRATION.

In October 1941, the *Economist* noted that ' two years of war brought remarkably few company mergers, but the third had opened well.' Since then several important transactions have been reported in the press, as for instance the Welsh colliery merger of Powell Duffryn and Cory Brothers, or the appointment of the chairmen of United Steel, Stewarts and Lloyds, and Lancashire Steel to the Board of Davy and United Engineering Co. Ltd. The former resulted in the largest composite colliery and oil business in the world, with a productive capacity of 22 million tons of coal a year, and with coal depots and oil installations on every important shipping route. Integration was also speeded up in the film and electrical industries, and among discount houses. The acquisition of Napier by General Electric Company, and of six theatres by Stoll are quite recent instances of industrial integration.

On the whole, information is only available about transactions relating to public or a few rather important private companies, and this information would suggest that among such companies the rate of trustification is not higher, possibly even lower than in the years preceding the outbreak of the war. The position may be quite different in regard to private companies and smaller concerns. A few cases of purchases of concentrated undertakings are known; many more have probably been carried out, and fuller information on this point would certainly be interesting.

War conditions considerably raised the death rate among small scale enterprises. In building, for instance, at least 11,000 firms employing less than 20 operatives have been squeezed out in the relatively short period between July 1941 and May 1942. Of a sample of retail shops in Leeds and Glasgow, 20% closed down in the course of 1940 and 1941, and this figure may well be representative for the whole country.[1] In assessing the trend of industrial organisation it would seem that outright integration is of lesser importance ; the disappearance of small units is more significant, but the decisive effect of the war has been the extension of cartels and cartel-like organisations into numerous new fields and their greatly increased power under war conditions.

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[1] BULLETIN Vol. 4, No. 14, p. 278 ; and Supplement No. 2, p. 1.